SHORT COMMUNICATION

BBA 73096

D-Arabinose influx across the brush border of rabbit ileum

In vitro studies of intestinal sugar absorption have suggested that sugars may be divided into two categories: (i) those that are subject to intracellular accumulation and transmural transfer against concentration differences ("active" transport) mediated by a Na^+-dependent, phlorizin-sensitive transport mechanism; and, (ii) those that are not actively transported and whose movements into or across intestinal tissue are neither enhanced by Na^+ nor inhibited by phlorizin[1,2]. Recently, BIHLER[3] has suggested that a common carrier mechanism may be responsible for the entry of both actively and non-actively transported sugars into hamster small intestine; the major difference being that the entry of actively transported sugars is markedly enhanced by Na^+, whereas the entry of non-actively transported sugars is insensitive to Na^+. The experimental evidence most strongly supporting this conclusion is the observation that the entry of non-actively transported sugars, such as D-arabinose, conforms to Michaelis–Menten kinetics and that the maximal rate of entry is the same as that of actively transported sugars. The concentration of arabinose needed to elicit a half-maximal influx was approx. 300–500 mM in the presence and absence of Na^+. In contrast, the concentration of 3-*O*-methyl-D-glucose, an actively transported sugar, needed to elicit a half-maximal influx was 500 mM in the absence of Na^+, but only 20 mM in the presence of 145 mM Na^+.

In order to examine the generality of BIHLER's hypothesis, we have investigated the kinetics of D-arabinose influx across the brush border of rabbit ileum. Previous studies have shown that the unidirectional influxes of actively transported sugars conform to Michaelis–Menten kinetics, are subject to competitive inhibition, are dependent upon Na and are markedly inhibited by 0.1 mM phlorizin[4]. The method for direct determination of the unidirectional influxes of solutes from the mucosal solution across the intestinal brush border and into the absorptive epithelium has been described in detail previously[5]. In essence this involves the brief exposure of a defined area of the mucosal surface to a mucosal solution containing [^{14}C]sugar and [^{3}H]-inulin. The initial rate of sugar uptake is calculated from the ^{14}C content of the tissue after correction for the [^{3}H]inulin space.

The unidirectional influx of D-arabinose in the absence of Na^+ is plotted as a function of the arabinose concentration in the mucosal solution in Fig. 1. In these experiments the tissue was preincubated for 30 min in a Na^+-free choline buffer as described previously[5]. Influx was determined from solutions containing 10 mM $KHCO_3$, 1.2 mM K_2HPO_4, 0.2 mM KH_2PO_4, 1.2 mM $CaCl_2$, 1.2 mM $MgCl_2$, D-[^{14}C]-arabinose and mannitol. The total mannitol *plus* arabinose concentration was 300 mM so that all solutions had a nominal osmolarity of 320 mosM. It seen that arabinose influx is a linear function of concentration over the range of 0 to 300 mM; no tendancy

toward saturation can be discerned. It can be shown that if influx conforms to Michaelis–Menten kinetics, a deviation from linearity should be apparent when the mucosal concentration is equal to, or greater than, 0.5 K_t. Thus the data in Fig. 1 indicate that if arabinose influx is a saturable process, the concentration needed to elicit a half-maximal influx (K_t) must significantly exceed 600 mM. A Lineweaver–Burk plot of these data results in a line whose intercept does not differ significantly from the origin.

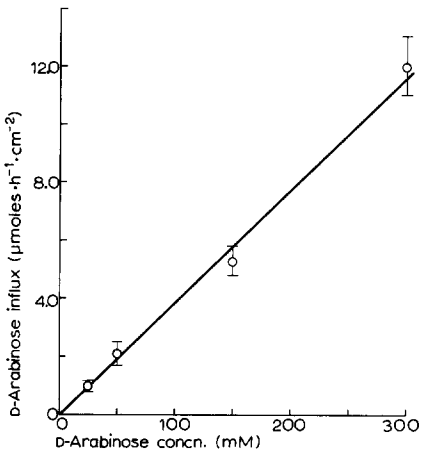

Fig. 1. Unidirectional influx of D-arabinose as a function of the arabinose concentration in the mucosal solution. Each point is the average of 4 determinations ± S.E.

TABLE I

All solutions contained the potassium, calcium and magnesium salts given in the text and had a nominal osmolarity of 320 mosM. Numbers in parentheses indicate the number of influx determinations. All errors are S.E.

Mucosal solution	*Arabinose influx* ($\mu moles \cdot h^{-1} \cdot cm^{-2}$)
150 mM arabinose + 150 mM mannitol	5.2 ± 0.4 (8)
150 mM arabinose + 75 mM NaCl	4.9 ± 0.8 (4)
50 mM arabinose + 125 mM NaCl	1.3 ± 0.2 (4)
50 mM arabinose + 125 mM NaCl + 25 mM D-glucose	1.1 ± 0.2 (6)
50 mM arabinose + 125 mM NaCl + 0.1 mM phlorizin	1.1 ± 0.1 (6)

The results of experiments examining the effects of Na^+, phlorizin and glucose on arabinose influx are given in Table I. In each instance, control and experimental influxes were determined on adjacent segments of tissue from the same rabbit. It is seen that influx in the presence of Na^+ does not differ significantly from the values obtained using mannitol solution. The presence of 25 mM glucose or 1 mM phlorizin in the mucosal solution did not significantly affect arabinose influx from a solution containing 125 mM NaCl.

In conclusion: We are unable to detect any evidence for the involvement of a "carrier" mechanism in the transport of D-arabinose across the brush border of

rabbit ileum. D-Arabinose influx appears to be predominantly the result of simple diffusion with a permeability coefficient of 0.04 cm/h; this value is, as expected, significantly larger than the permeability coefficient of mannitol, 0.016 cm/h. We are unable to detect any similarity between the characteristics of arabinose influx and the features that characterize the influxes of glucose, galactose and 3-*O*-methylglucose[4]. In particular, the failure of glucose to inhibit arabinose influx would seem to be strong evidence against the presence of a common carrier mechanism for these sugars.

We are unable to reconcile the present results with those reported by BIHLER[3] for hamster small intestine. Species differences may, of course, be involved. However, this conclusion has profound implications and, like any other conclusion, should be supported by direct, positive experimental evidence. An alternative explanation, that must be excluded before species differences can be invoked, is that methodologic differences are responsible for these results. BIHLER's data reflect net uptake by whole segments and everted sacs of hamster small intestine during 30–40 min of incubation. Thus, uptake by the tissue involves movements across, and equilibration with, the serosal tissues (muscularis, submucosa, *etc.*) as well as flows across both the mucosal and serosal membranes of the absorptive cells. Further, BIHLER's data indicate that in some instances, the tissue concentration of arabinose approached 50 % of that in the incubation medium (Fig. 3, ref. 3); entry rates calculated from these data cannot be considered initial rates. These complications must influence the resulting kinetic pattern and could be responsible for the differences between the present results and those reported by BIHLER.

This study was supported by research grants from the U.S. Public Health Service, National Institute of Arthritis and Metabolic Diseases (AM-13744) and the American Heart Association (67-620), and by a Public Health Service Research Career Development Award (K4AM-9013) from the National Institute of Arthritis and Metabolic Diseases (S.G.S.).

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Received October 27th, 1969